Subjective rating of perceived back pain, stiffness and sleep quality following introduction of medium-firm bedding systems

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ABSTRACT

Purpose: To compare personal and new bedding systems between subjects with reported high and low base line sleep quality.

Methods: A convenience sample of healthy subjects (women = 30; men = 29) with no clinical history of disturbed sleep participated in the study. Subjects recorded perceived back discomfort and stiffness, sleep quality and comfort, and sleep efficiency upon waking for 28 consecutive days in their own beds (baseline) and for 28 consecutive days (post) on a new bedding system. Repeated measures analysis of variance was used to treat sleep data.

Results: Analysis revealed significant differences between pre- and post means in all areas for both high and low sleep quality groups. Analysis of sleep efficiency also yielded significant differences between, but not among pre- and post means. Improvement of sleep comfort and quality became more prominent with time (from wk 1 to 4 post observation).

Conclusions: Similar significant benefits of new, medium-firm bedding systems can occur for those reporting both good and poor current sleep quality and variables such as age, weight, height, and body mass index are independent of such improvements. (J Chiropr Med 2006;5:128–134)

Key Indexing Terms: Beds; Back Pain; Sleep

INTRODUCTION

In the year 2000, over 60% of surveyed Americans reported at least 1 sleep problem symptom per week and in 2005, 75% reported sleep problems.[1] Millions of people are affected by sleep problems in various degrees of severity. For instance, while over half of all adults report occasional sleeping difficulty approximately 12 in 100 adults report regular sleep difficulty.[2] According to the National Sleep foundation, 26% of Americans reported a good night's sleep only a few times per month or less.[1] Lack of sleep has been targeted as a frequent problem in today's society and it is suggested that a high proportion of individuals in the workplace are sleep deprived (www.sleepnet.com). Physiologically and psychologically, sleep acts in a restorative manner[3] to aid in healing and repair. A deficiency of sleep interferes with daytime activity, social interactions, and mood[4] which can also be associated to loss of work production and injury.

Both physiological and psychological circumstances or pathology may affect sleep quality; however, most individuals with minor sleep disturbance associate work or family related stress or physical discomfort with poor sleep. It also has been reported that sleep problems were related to an uncomfortable mattress or sleep surface[5] resulting in complaints of low back discomfort, pain, or stiffness and shoulder pain.[6,7]

Researchers have concluded that firmness and/or construction of the bedding system may be associated with sleep quality. In a comparison of foam and innerspring mattresses, one study found no differences in sleep stages, number of wakes, or total sleep time.[8] Another study found that subjects who slept regularly on cotton mattresses developed back pain after one night's sleep on 10 cm thick foam mattresses, but were relieved of pain when returning to their softer cotton mattresses.[9] Garfin and Pye,[10] using subjects with chronic back pain, compared "hard", "softer", water, and water/foam beds

and noted that the subjects reported a reduction in back pain as a result from sleeping on the "hard" beds. Jacobson et al[11] concluded that medium firm mattresses reduced clinically diagnosed back pain, shoulder pain, spine stiffness and positively affected sleep quality, and in a study comparing mattress firmnesses, participants with chronic low back pain reported a greater reduction in pain when sleeping on a medium-firm mattress compared to a firm mattress.[12] In another study, subjects with chronic back pain reported a decrease in pain when sleeping on an adjustable air bed compared to sleeping in their personal beds.[13]

With the extent of musculoskeletal sleep loss related disorders, it is reasonable to assume that health professionals are frequently asked for sleep surface recommendations, but no formula exists for recommending bedding systems for the purpose of reducing sleep disturbances and increasing sleep quality, thus, health care professionals have little consistent or reliable information to reference when asked to recommend sleep surfaces.[14] Yet, in a survey of orthopedic surgeons, 95% indicated they believe that the mattress their patients slept on was a factor in back pain and 75% said they recommended firm or hard mattresses.[15] In response to previous recommendations, experts have stated that it is not prudent for physicians to recommend either a firm or a medium-firm mattress for patients presenting with chronic low-back pain because so little is known about the relationship between sleep surfaces and back pain.[16] The purpose of this study was to compare perceived sleep quality before and after replacing the subjects' personal bedding system with a contemporary, medium-firm sleep surface.

METHODS

Subjects

The subjects (N=59) consisted of a sample of 30 women and 29 men who slept on commercially made spring mattresses. All participants indicated varying degrees of musculoskeletal related sleep disturbance, but had not been clinically diagnosed and treated (with manipulation or pharmaceuticals) for sleep disturbance. Inclusion in the study was restricted to apparently healthy subjects without diagnosed musculoskeletal pathology or on medication for chronic pain or sleep disorders. Subjects' physical characteristics are illustrated in Table 1. All subjects were orally briefed on the conditions of the

VARIABLE	MALES (N = 29)	FEMALES (N = 30)	TOTAL (N = 59)
AGE (YRS)	MEAN = 46.89 SD = 11.3	MEAN = 43.43 SD = 10.8	MEAN = 45.14 SD = 10.9
HT. (CM)	MEAN = 179.04 SD = 7.62	MEN = 165.0 SD = 5.59	MEAN = 171.91 SD = 9.63
WT. (KG)	MEAN = 89.73 SD = 11.9	MEAN = 65.55 SD = 1.52	MEAN =.77.43 SD = 16.87
BMI	MEAN = 27.79 SD = 3.74	MEAN = 24.55 SD = 4.16	MEAN = 25.94 SD = 4.27

study and signed an informed consent document approved by the Oklahoma State University Institutional Review Board. As previously used by Bader and Engdal,[17] to maintain the essential need for reducing external, contraindicating factors and to provide the most natural sleep environment, subjects slept in their own bedrooms with their personal linen and pillows. Subjects also controlled their own thermal environment and no attempt was made by the investigators to suggest altering their typical room temperature.

Procedures

Subjects were asked to complete 2 questionnaires; one questionnaire was related to sleep habit and the other questionnaire contained 32 items related to behaviors manifested by anxiety, restlessness and stress, all of which can interfere with normal sleep. Visual analog scales (VAS) were used to assess the participants' perception of 5 separate dependent variables and were to be rated each morning immediately after rising. VASs provide an accurate measure of subjective pain and have been used in several studies.[11,13,18,19]

For the current study the dependent variables were: 1) low back discomfort, 2) spine stiffness, 3) sleep quality, 4) sleep comfort, and 5) sleep efficiency. Sleep efficiency was defined as the proportion of time in bed with time spent asleep and is another common measure of sleep quality.[17]

The VASs consisted of 10 cm lines with polar extremes. The VASs for back pain contained "no pain" on the far left and "extreme pain" on the far right side of the line. The spine stiffness VAS contained "no stiffness" on the far left, and "extreme stiffness" on the far right side of the line. Sleep quality and comfort VASs contained "excellent" on the far left and "poor" on the far right side of the line. Sleep

efficiency was calculated as the subjective proportion between the amount of time spent in bed and the amount of time slept.

To render suitable discriminates between those with high (HP) and low (LP) back pain baseline and high stiffness (HS) and low stiffness (LS) the determinate for "high" and "low" pain and stiffness was made by eliminating from analysis 20% of the middle range of pre-total VAS raw scores (40–60mm) for each of the measures (back pain and stiffness), thus capturing only those reporting high (≥60) and low (≥40) pain. For sleep quality and comfort, identical exclusionary VAS scores were used, but high quality (HQ) and comfort (HC) scores (≥60) indicated a trend toward good quality and comfort and low (≥40) quality (LQ) and comfort (LC) scores a trend toward poor quality and comfort.

Similar to other studies, phase 1 (baseline) required subjects to sleep in their own beds[11,17] and to rate each dependent variable upon waking for 28 consecutive days.[11,13] Ratings were executed by placing a mark through the VAS line that corresponded to their individual perceptions of pain, stiffness, and sleep quality. Subjects were to rate the categories each morning after sleeping in their own bed and were cautioned to avoid rating their sleep following instances of heavy alcohol consumption, trauma, or any extraordinary emotional or physical event that could have detrimental effects on sleep.

Phase 2 (experimental phase) was initiated following the delivery of the new bedding systems to each subject's place of residence. Beds were specifically manufactured for this study with several generic components to conform to a medium firm sleep surface. Beds were constructed of a foam encased bonnell spring unit, densified fiber pad, super-soft foam, damask cover, semi-flex foundation and slick fiber and represented the same size bed that the subjects' had slept on originally. Subjects continued to use their own linen, blankets and pillows. Following delivery of the bedding system, subjects were again required to rate the aforementioned variables for another 28 consecutive days.

Statistical Analysis

Data were collected on 5 dependent variables via 280 (140 pre- and 140 post-) observations per subject. The total 28-day mean for phase I was established as the baseline for each dependent variable

and subsequently compared with the four, one week means in phase II. Phase I and phase II means for back pain, stiffness, sleep quality, sleep comfort, and sleep efficiency were analyzed using analyses of variance (ANOVA) with repeated measures. Significant group differences were further treated by Newman-Keul post hoc tests. An alpha level of $p < 0.05$ was considered significant. Analyses of age, height, weight, BMI and bed cost and previous bed softness was done by multiple regression, inclusive of regression coefficients (Beta), standard error of Beta, and p-levels.

RESULTS

Initial data indicated that the mean bed age was 9.73 yrs (SD=4.98) and less than 40% of the subjects indicated that their bed was medium-firm. Analysis yielded significant improvement in back discomfort for both the high ($F[4,44] = 31.58$; $p < 0.0001$) and the low ($F[4,120] = 9.45$; $p < 0.0001$) baseline groups. Post hoc analysis resulted in significant differences ($p < 0.05$) between baseline means and all post-observation means (weeks 1–4) for the high pain (>60) baseline group and significant differences between baseline and post observations for week 2, 3, and 4, but not between baseline and week 1 for the low (<40) pain group (Fig 1).

Similarly, significant improvements were found in spine stiffness for the high ($F[4,60] = 37.78$; $p < 0.0001$) and for the low ($F[4,120] = 4.46$; $p < 0.0021$) baseline groups. Post hoc analysis resulted in significant improvements in stiffness between baseline means and all post-observation means (weeks 1, 2, 3, and 4) for both high and low groups (Fig 1).

Analysis yielded significant improvements in sleep quality for both the high ($F[4,84] = 63.53$; $p < 0.0001$) and the low ($F[4,148] = 31.62$; $p < 0.0000$) sleep quality groups and significant improvements in sleep comfort for the high ($F[4,44] = 62.00$; $p < 0.0001$) and low ($F[4,120] = 28.96$; $p < 0.0001$) sleep comfort groups. For both variables and both high and low baseline groups post hoc analysis revealed significant improvement between baseline and all post means (weeks 1, 2, 3, and 4) (Fig 2).

Multiple regression analysis for pre-test baselines revealed that body weight was a significant predictor for back pain (Beta = 0.58, $p < 0.05$) and stiffness (Beta = 0.51, $p < 0.05$), and a strong but not signifi-
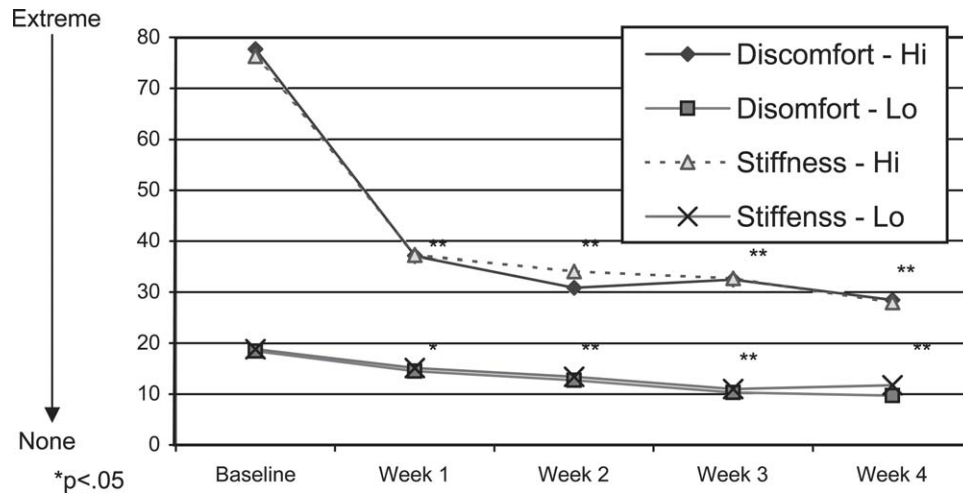
Figure 1. Back discomfort and stiffness by high (hi) and low (lo) baseline ratings.
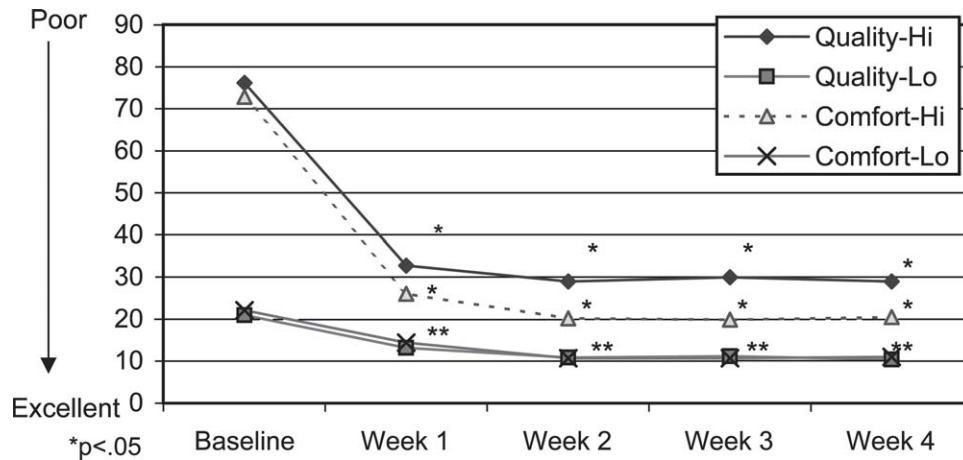

Figure 2. Sleep quality and comfort by high (hi) and low (lo) baseline ratings.

cant predictor for sleep quality (Beta = 0.26) and comfort (Beta = 0.17). Pre test baselines also indicated that height was a significant predictor of back pain (Beta = 0.40, p < 0.05) and stiffness (Beta = 0.49, p < 0.05). Bed age appeared as one of the stronger predictors of stiffness (Beta = 0.28. p < 0.05). Also, bed softness was a strong predictor of lower back pain (Beta = 0.36, p < 0.05) and stiffness (Beta = 0.39, p < 0.05). For post test regression analysis, only subjects' age provided a significant (Beta = −0.28, p < 0.05) predictor, and then only in sleep comfort. No other variable had significance in predicting poor sleep in the posttest session.

While sleep efficiency for both high (>90%) and low (<86%) baseline groups improved significantly (F(2,48) = 3.85; p < 0.028) and (F(2,42) = 14.54;

p < 0.0001 respectively) between baseline and post observations (Fig 3) the group reporting the poorest baseline sleep efficiency improved significantly more than the high sleep efficiency baseline group. Table 2 represents the degree of improvement found between baseline and last (week 4) observation point.

DISCUSSION

While Bader and Engdal,[17] found no significant difference in sleep quality or preference among subjects' ratings of their own beds, and 2 commercially available beds marketed as "soft" and "hard", 4 of 10 subjects preferred the harder and 5 of 10 the soft bed. In contrast, the present study found significant improvements in all dependent variables between
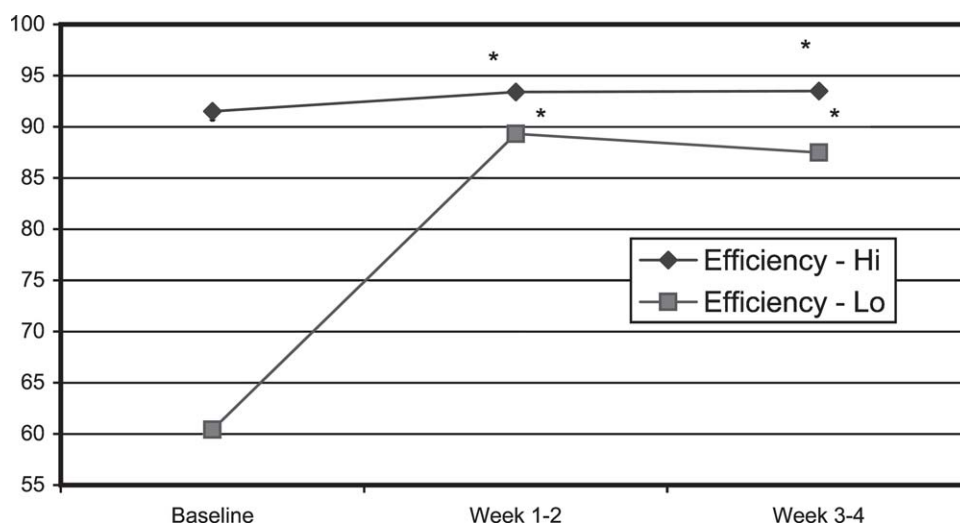
Figure 3. Sleep efficiency by high (hi) and low (lo)baseline ratings.

TABLE 2
IMPROVEMENT FOUND BETWEEN BASELINE AND
LAST (WEEK 4) OBSERVATION POINT

VARIABLE	HIGH GROUP (%)	LOW GROUP (%)
LOW BACK PAIN	+63.3	+47.3
SPINE STIFFNESS	+63.3	+38.0
SLEEP QUALITY	+65.8	+58.1
SLEEP COMFORT	+77.3	+64.2
SLEEP EFFICIENCY	+4.4	+3.8

the subjects' own beds and a medium-firm bed. Differences in experimental protocols between Bader and Engdal[17] and the present study, the number of participants, and the type of mattresses used may have accounted for contrasting results. Bader and Engdal[17] suggested that changing bedding systems may initially improve sleep via a pseudo placebo-effect and proposed that it may take more than 5 nights to adapt to the new surface. In the present study, subjects realized immediate and sustained benefits in all areas of measurements from the new bedding systems and the perceived benefit amplified with each week of reporting.

With respect to the magnitude of contribution to sleep difficulty by the independent variables, body weight provided the strongest factor in all areas. That people who are obese frequently suffer from sleep disorders is well documented.[20,21] Research suggests that a correlation between body weight and sleep related body movements/shifts exists[17] and that those with less body weight are more likely to have higher sleep quality than heavier and more obese subjects. The mean BMI of the current study

participants' could be categorized as overweight.[22] Recently Namyslowski et al[23] concluded that BMI can be used as a predictor of certain sleep disorders. While Bader and Engdal[17] found positive, but not significant correlations between subjects' height and body movement index and total duration of movements during sleep, the present study provided data that indicated that individual height contributed significantly to back discomfort and stiffness upon waking.

Enck et al[14] found that the quality and price of the mattress correlated with perceived sleep quality presumably due to the type of construction and materials used in the manufacturing process. Sharf et al[8] found that normal subjects' cyclic alternating patterns (CAP rate) were reduced and blunted on a foam support mattress in comparison to sleeping on a high quality innerspring mattress. The current study found a significant pre-test contribution by soft sleeping surfaces toward both lower back discomfort and stiffness. Related to construction, some mattress advertisements contain illustrations on how the contour of the bed surface conforms to that of the body. However, Bader and Engdal[17] suggest that there is no evidence that a change in spine curvature is produced when sleeping on either hard or soft surfaces. Lahm and Iaizzo[24] concluded that while adjustment in air mattress inflation pressure produced significant changes in spinal alignment, the observed changes were of, ". . . little physiological consequence."

In the current study, bed age contributed significantly to baseline back stiffness. It is possible that

while mattresses and bedding surfaces are accompanied by extended warranties, the life of the mattress as it relates to sleep quality may be considerably less than previously thought. It should be noted that participants' bed age were 5 years and older with a mean bed age of approximately 9 years.

In analyzing the contributing factors for poor sleep in the posttest segment, significance ($p < 0.05$) for all previously discussed factors (weight, height, bed age, softness) disappeared. However, age became a significant contributor for sleep comfort. It is generally accepted that sleep disorders increase with age[25] and that with age certain biochemical agents relative to sleep are compromised.[26] Melatonin has been recommended as possible treatment for such sleep disorders.[27]

The current study employed a medium-firm sleep surface as the experimental bedding system and found immediate and significant improvements in back discomfort and stiffness and in sleep comfort, quality, and efficiency among both high and low baseline participants. Further, the initial significant contributors to poor sleep were not present as significant factors following 28 days of sleeping on a medium-firm surface. These data correspond to conclusions made by both Lahm et al[24] and Kovacs et al[12] in that medium-firm sleeping surfaces were preferred by normal, pain-free participants and that medium-firm sleeping surfaces provided better outcomes for chronic back pain relief.

The present study suggests that medium-firm bedding systems provide improved sleep quality and efficiency. Further, those suffering from minor musculoskeletal sleep related problems may obtain similar sleep quality benefits as patients who have been clinically diagnosed with musculoskeletal ailments which interfere with sleep quality.[17] No benchmark standard presently exist for recommending bedding systems, whether for the purpose of alleviating chronic sleep disturbance or for the purpose of enhancing sleep quality. Health care professionals are often asked to recommend a sleep surface that can improve sleep quality. However, the ideal mattress is yet to be determined and the existing dearth of information involving the role of sleep surfaces in relationship to sleep disorders, pain, and quality of sleep is reflective of a need for further research. As a practical approach and one that is supported by this study as well as others, health professionals may safely recommend a medium-firm sleep surface

with a certain degree of confidence for patients with minor musculoskeletal sleep disturbance. While not directly a focus of the present study, the literature suggests that recommending a weight loss program for those who present with poor sleep with body mass indices on or about the obese range may further benefit the patient. A weight loss program should also consist of exercise which may be of benefit in sleep disorders.[28]

CONCLUSIONS

Medium-firm bedding systems can provide some benefits for those reporting both good and poor current sleep quality and variables such as age, weight, height, and body mass index seem to be independent of such improvements.

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